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3 to 5 Years Old Children's Behavioral and Verbal Performances in Level 1 Perspective-Taking

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Abstract: The study aimed to investigate the level 1 perspective-taking of 3 to 5-year-old children and to explore the potential differences between their behavioral and verbal performances. Specifically, Experiment 1 adopted the "one-way mirror" paradigm to capture the performances of 54 children. Logistic regression analysis showed that children's behavioral performances were almost the same across ages (B = −0.225, Wald = 0.38, p = 0.541). ANOVA analysis also found that there was no discrepancy between behavioral and verbatim data. Given the limitations of the scoring system and lacking control of natural preference in the behavioral paradigm, we improved it in Experiment 2 by applying a hide-and-seek game to another group of 60 children. Three-way ANOVA analysis indicated significant interaction among task type, age and gender (F (2, 48) = 3.55, p = 0.037, η^2 = 0.13). These results suggested that the behavioral performances improved from 3 to 5-year-olds in both girls and boys, with boy s' verbal responses improved to a lesser extent than girls'. Taken together, these findings suggested that a behavioral task might provide additional information to tasks designed merely to capture verbal responses when assessing children's level 1 perspective-taking.

Key words: perspective-taking; strategy use; behavioral performance; verbal performance

Perspective-taking refers to the ability individuals possess to distinguish opinions of themselves from others, and make correct judgment about other's opinions according to past or present information (Berk, 2004; Herold & Akhtar, 2008). Perspective-taking can be classified into two subtypes: visual perspective-taking and social perspective-taking (Rubin, 1978). Most studies on visual perspective-taking have focused on whether individuals were able to perceive others' attention conditions to obtain knowledge and experiences during social communication (Flavell, 1992; Flavell, Everett, & Croft, 1981; Masangkay, McCluskey, McIntyre, Sims-Knight, Vaughn, & Flavell, 1974; Ames, Jenkins, Banaji, & Mitchell, 2008). As vision is the main channel for individuals to receive external information, whether individuals could form an appropriate representation of others' perspectives, and perform properly on this basis are of great importance.

Visual perspective-taking can also be classified into two levels: level 1 and level 2 (Flavell, 1992). Level 1 perspective-taking means children know what they see may differ from what others see, whereas level 2 perspective-taking means children understand that they and another person may see the same thing with different perspectives. In the current study, we focused on level 1 perspective-taking in typically developing children because it has been regarded as the beginning of children's understanding of others' mental states (Barnes-Holmes, McHugh, & Barnes-Holmes, 2004; Gopnik & Slaughter, 1991), also comparing behavioral and verbal performances of this level might be more sensitive in detecting the developmental repertoire of these children.

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Extensive work has been done on the assessment of the developmental process of children's level 1 perspective-taking, including verbal and non-verbal studies. However, several different studies have failed to draw a definite conclusion. The classical verbal paradigm of level 1 perspective-taking involves the use of a two-sided card as the testing material, with a cat on one side and a dog on the other (Masangkay et al., 1974). In this task, children were instructed to answer what they saw and what the other person would see when they looked at one side while the experimenter faced the other side of the card. Half of the 2-year-olds were shown to pass this verbal task and 3-year-olds' performances were near ceiling (Flavell, 1999; Masangkay et al., 1974). On the other hand, tasks designed to specifically capture non-verbal level 1 perspective-taking ability found that children at 2- and 2.5-year-olds could pass the non-verbal tasks (Flavell et al., 1978; Moll & Tomasello, 2006). More importantly, based on the differences of infants' looking times in the violation-of-expectation paradigm, recent studies attempting to test whether infants could represent beliefs also indicated that infants younger than 2-year-old were able to distinguish others' visual perspective from their own (Onishi & Baillargeon, 2005; Sodian, Thoermer, & Metz, 2007; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007).

The aforementioned studies revealed that children who showed level 1 perspective-taking in behavioral tasks were frequently younger than those who showed level 1 perspective-taking in verbal tasks. Therefore it seems that due to the lack of proficient linguistic and memory capacities, children may fail to demonstrate their potential level 1 perspective-taking ability in verbal tasks. However, the designs and methodologies adopted in these studies were different. For example, studies using the violation-of-expectations paradigm might indicate infants' implicit understanding of mental states or visual perspective (Onishi & Baillargeon, 2005; Sodian, Thoermer, & Metz, 2007; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007). On the other hand, studies demanding the children to demonstrate active performances, either by words or behaviors, might show children's explicit understanding of visual perspective (Flavell, 1978; Moll & Tomasello, 2006). Therefore, we cannot compare these findings directly. Furthermore, Carlson, Moses, and Hix (1998) found that if the target behaviors were more demanding of children's inhibitory control, they might perform worse in behavioral tasks than in verbal tasks. There is a lack of a direct comparison of behavioral and verbal performances of children's explicit level 1 perspective-taking, making it difficult for us to get a thorough picture of the children's perspective-taking ability.

To address this question, we modified extensive tasks to compare children's behavioral and verbal performance directly. Given some of the commonalities of the developmental repertoires between human children and non-human primates, we chose a paradigm developed by Povinelli that was originally designed for primate study (Povinelli, 1994; 1996). This paradigm consists of a non-verbal task to capture non-human primates' level 1 perspective-taking. There were two experimenters, one was facing forward and the other was facing away, the primates were trained to beg for food from either experimenter. These non-human primates seemed to have the level 1 perspective-taking, for they asked the one facing them for food much more often than the other. However, it was possible that their performances were just out of the inclination to ask the experimenter directly facing them for help. Hence, we made a modification on this paradigm by adding a control condition, in which both of the two experimenters could not see the subjects directly, to rule out the influence of the inclination in the experimental condition. Moreover, in order to compare the verbal and behavioral performances directly, we made some changes to the contents of the questions in the verbal paradigm (Masangkay

et al., 1974) in our experiment. The questions were asked after the behavioral task, and children had to answer whether the experimenter facing forward and the one facing away were able to see the other side.

Based on the aforementioned findings, we would like to compare behavioral data and verbatim data directly, and we speculated that behavioral data might be more sensitive than verbatim data in capturing the development of level-1 perspective-taking in children. Moreover, researchers found that girls had some superiority over boys on verbal tasks (Thomas, Lohaus, & Brainerd, 1993). Studies about the developmental patterns of children's spatial ability also revealed that girl's verbal precocity may provide them an advantage in verbal testing situations (Johnson & Meade, 1987). Thus, would gender have any effect on the deviation between behavioral and verbatim data? We attempted to explore this interaction in the current study. We hypothesized that girl's verbal performances would be better than boy's, with non-significant differences in their behavioral performances.

1 Experiment One: Level 1 Perspective-taking Game

1.1 Method

1.1.1 Participants

Participants were 54 typically developing children recruited from the Kindergarten of Beijing. There were three age groups: 18 children (8 girls, 10 boys) were 3 years old (M = 3; 3, range = 3; 1-3; 7), 19 children (9 girls, 10 boys) were 4 years old (M = 4; 5, range = 4; 1-4; 11), and 17 children (9 girls, 8 boys) were 5 or more than 5 years old (M = 5; 10, range = 5; 3-6; 5).

1.1.2 Materials and design

A one-way mirror (1.50m high, 2.00m long) standing in the middle of the room, split the room into two same halves. Four boxes which could hide small toys were placed on one side of the one-way mirror. Two stools were placed on the other side. A lot of toys could be chosen by children to use in the finding game (Figure 1).The two sides of one-way mirror have different optical properties. The transparent side is equal to a limpid glass and light could go through it, and when the experimenters are seated at this side, the condition would be the same as the experiment of Povinelli (1994, 1996). The other side of the one-way mirror is obscured, and subjects' behaviors at this side could serve as the controlled condition to investigate whether the performances in the experimental condition just reflected the inclinations to experimenters facing them. Children were tested in one session of about 10 minutes. Each time two children of the same sex were tested together and the test orders were balanced. Each child received a trial on each side of the one-way mirror separately.

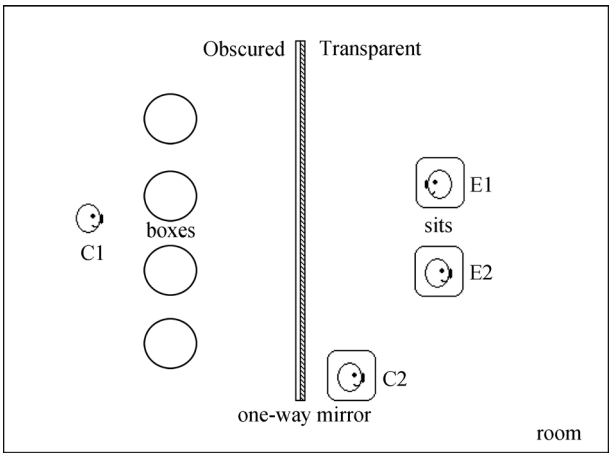

Figure 1. Aerial view of the experimental layout.

Note. E1, E2 represented the two experimenters, and C1, C2 represented the two children taking part into the experiment. There was a one-way mirror in the middle of the testing room. The four round boxes on the left were obscured, and were used for hiding the toys, while the two square stools on the right were for experimenters to sit on. During the experiment, the experimenters and children's situations were shown in this configuration. During the trial presented in this figure, E1 could see anything on the opposite side of the one-way mirror (*transparent condition*); and after both of the children had played the role of C1, the same test was done on the other side of the one-way mirror again. In this new trail, C1's behavior could not be seen from the other side (*obscured condition*).

1.1.3 Procedure

The tests were administered in a quiet room (4.00m × 3.00m). Before the experiment started, there was a 5-minute warm-up procedure: the two

experimenters, each with a child, encouraged the children to explore the one-way mirror, guiding them to focus on the one-way mirror and to look through it from both sides. During this process, the experimenters tried to demonstrate to the children how the situation was perceived from both sides, by asking them to communicate with each other about what they could see or could not see when they were at different sides of the one-way mirror. After they were familiar with the one-way mirror as well as the testing environment, the children were asked to choose one toy. Then E1 (experimenter 1 in Figure 1) showed and taught children how to hide the toy in the box. After that, each child played as a hider on each side of one-way mirror, meaning a total of 4 hide and find games. while C1 (child 1 in Figure 1) stayed with the boxes, C2 (child 2 in Figure 1) sat on the side of the one-way mirror opposite to the boxes, staring at the two experimenter's stools. Then, both experimenters sat on the stools, with E1 facing toward the one-way mirror and E2 (experimenter 2 in Figure 1) facing away. Finally, the experimenters asked C1 to choose a box of the four to hide C2's toy in it. After that, both experimenters helped C2 to find the toy by pointing to a box separately, and told C2 "I think the toy is in this box" at the same time. Moreover, C2 was told that he or she could get the toy back home if he or she could find the toy at the first time. However, if C2 failed to find the toy, he or she was allowed to continue searching. Then, C2 was asked, "When C1 was hiding your toy, where were you? Where was E1, and how did E1 sit? What about E2? " (Memory-control Question), followed by the Level 1 Perspective-taking Question, "When C1 was hiding your toy, could E1 see him/her? How about E2? "

The children's verbal responses and behaviors were recorded, and the orders of these two measures were counter-balanced within each age group. After C2 had finished both tests, the children changed their roles with each other, and repeated the whole experiment. To compare the difference between children performances in the *transparent condition* and in the *obscured condition*, the same test was done on the other side of the one-way mirror again. All the experimenters and children moved to the other side of the one-way mirror in the *obscured condition.*

1.1.4 Coding and scoring procedure

All the children answered both of the two memory-control questions correctly, thus, none of them were excluded from the analysis in use of the verbal responses score. There was one level 1 perspective-taking question in each of the two conditions: when the experimenters were at the transparent side, the child who answered "yes" to E1 and "no" to E2 could get 1 mark, other answer types would get 0; correspondingly, when the experimenters were seated at the obscured side, the child who answered "no" to both experimenters could get 1 mark, and other answers scored 0. Hence, children's verbal response scores were the sum of the two (range from 0 to 2). In the behavior task, for both *transparent and obscured condition*, the child who at first searched the box which E1 pointed to could get 1 mark, and the one who searched the box which E2 pointed to could get -1 mark. If the child did not listen to either experimenter, he/she got 0.

1.2 Results and Discussion

1.2.1 Children's behavioral performances

Logistic regression analysis was used to compare children's behaviors of following E1 across different age. In both *the transparent and obscured conditions*, the effect of age was not significant (in the *transparent condition:* $B = -0.225$, Wald = 0.38 $p = 0.541$; in the *obscured condition:* $B = -0.298$, Wald = 1.18 $p = 0.278$). Thus, it seemed that 3-year-olds' behavioral performance was almost the same as 5-year-olds. It might suggest that even 3-year-olds had demonstrated level 1 perspective-taking in the current experiment. This result was consistent with previous studies (Masangkay et al., 1974; Moll & Tomasello, 2006).

Then, we analyzed whether children's choices of following E2 differed across the age in the transparent condition (Figure 2). The result showed that the effect of age was significant (B = –1.150, Wald = 4.18, p = 0.041), with older children less likely to follow the E2's point. Specifically, all of the 5-year-olds refused to follow E2. In order to further examine the relationship between children's performances in *transparent condition* and *obscured condition*, we investigated the pattern of children's behaviors and the percents of children whose performances fit those patterns of each age besides the original coding (Table 1). The findings suggest that, 3-year-olds tended to follow E1 in both conditions, 4-year-olds' choices showed no preference, and none of the 5-year-olds followed E2.

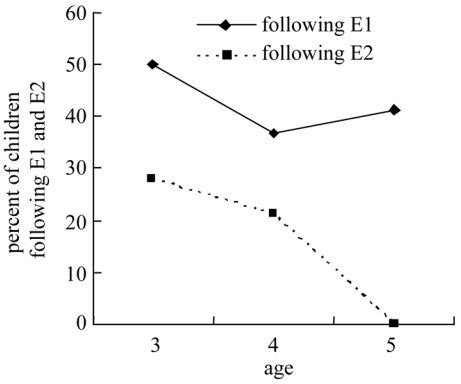

Figure 2. Percent of children following E1 and E2 in the *transparent condition*

Note. In the *transparent condition*, the percentage of children following E2's point decreased significant across age, and the percentage of 5-year olds who followed E2 was 0.

Table 1
The percent of children on different conditions (%)

In transparent condition	*In obscured condition*	3-year-olds	4-year-olds	5-year-olds	Total
Followed E1	Followed E1	27.8	5.3	17.6	16.7
Followed E1	Followed E2	11.1	5.3	5.9	7.4
Followed E2	Followed E1	0	15.8	0	5.6
Followed E2	Followed E2	11.1	5.3	0	5.6
Didn't listen	Didn't listen	5.6	31.6	35.5	24.1

Note. As they grew older, more and more children choose to follow neither of the experimenters. 3-year-olds tended to follow E1 in both conditions, but 4-year-olds did not show any preference. None of the 5-year-olds made the choice of following E2 in the *transparent condition*.

Taken together, we speculated that older children's obvious refusal to follow E2 might reflect a development of strategy use: although they were not sure which experimenter gave the correct information, they might be certain that the safest way was to exclude the most impossible choice (E2, who was absolutely chosen by guess). For the 4-year-olds, however, their unclear performances might indicate that their strategy usage was not well developed. Thus, the results were similar to findings that strategies adopted by 4 and 5-year-olds differ significantly even within this 1-year period (Sigler & Shipley, 1995). This developmental pattern was also in accordance with the Strategy Choice and Discovery Simulation Model (SCADS), which argues that there is a significant progression of strategy development between 4- and 5-year-olds (Shrager & Sigler, 1998; Sigler, 1999).

1.2.2 Comparison of children's behavioral and verbal performances

To compare the behavioral data and verbatim data directly, we transformed them into standardized scores. A 3 (age) × 2 (gender) × 2 (task type) mixed-design ANOVA with task type as a within-subjects factor revealed that none of the three-way interaction, two-way interaction, or any other main effects were significant (Figure 3). We excluded gender from the subsequent analyses. A 3 (age) × 2 (task type) mixed-design ANOVA indicated that only the main effect of age was significant, F (2, 48) = 3.80, p = 0.03, η^2 = 0.15. The overall scores of the 5-year-olds were significantly higher than those of 3-year-olds (p =

0.042). These results meant that both behavioral and verbal tasks could discern the development of level 1 perspective-taking from the 3-to-5-year olds to the same extent. Thus, Experiment1 failed to find the expected advantages of behavioral paradigm.

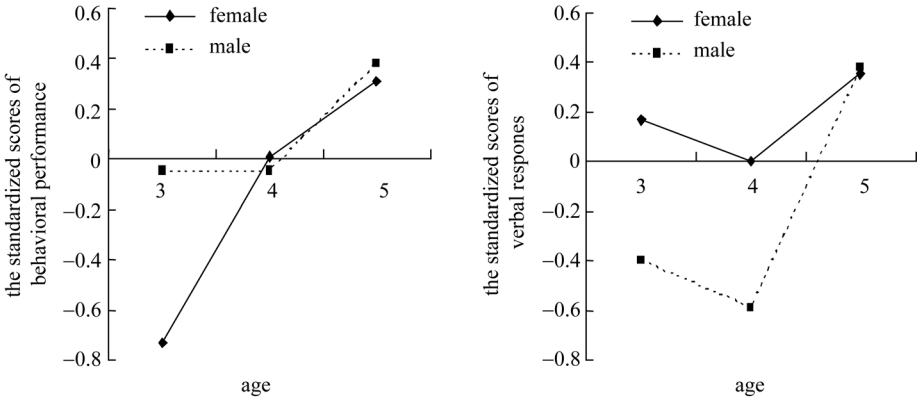

Figure 3. Mean of children's behavioral data and verbatim data (standardized) by age and gender

The insignificant differences between the two measures might be caused by several limitations of the current experiment. Firstly, it was possible that the behavioral paradigm, in using of the one-way mirror, might be too complex, and hardly understood by children. Secondly, children's behaviors were likely to be attributed to their natural preference. It was possible that even though C2 knew none of the experimenters could see C1's actions in the *obscured condition*, they might still tend to follow E1, as E1 was facing forward the one-way mirror, and seemed more likely to know the truth. Thirdly, the coding and scoring system of the current behavioral paradigm might be too simple to match the verbal paradigm. Moreover, the paradigm used in non-human primate studies might not be suitable for human children.

2 Experiment Two: Hide-and-seek Game

Given the limitations of Experiment 1, we designed Experiment 2 to address the problems and make a better comparison of children's behavioral and verbal performances. We made some improvements to the behavioral paradigm used in this experiment. Firstly, we employed the hide-and-seek game as the experimental task. Children are familiar with hide-and-search for objects. For example, even infants could search for objects from before their first birthday (Moll & Tomasello, 2006). Thus, this familiarity might make it easy for them to master the task we used. Secondly, we controlled the chance level of performing correctly in the behavioral task as 25%, making it less possible that children's correct behaviors were outcome of their natural preference. We also conducted two control trials to check whether children's performances were just outcomes of strategy use or their hiding preferences. Thirdly, children were able to perform more actively and demonstrate more behaviors during the current hiding-game task. Thus, according to the observations of their various behaviors, we were able to develop an elaborate coding method to encode children's behaviors during the experimental trial, and powerfully make a direct comparison of their behavioral and verbal performances.

2.1 Method

2.1.1 Participants

Participants were 60 typically developing children recruited from the Kindergarten of Beijing. There were divided into three age groups: 19 children (9 girls, 10 boys) were 3 years old (M =

3;05, range = 3;00-3;10), 24 children (11 girls, 13 boys) were 4 years old (*M* = 4;07, range = 4;00-4;11), and 17 children (9 girls, 8 boys) were 5 years old (*M* = 5;09, range = 5;00-6;05).

2.1.2 Materials and design

A one-way mirror identical to the one used in Experiment 1 was used in this experiment. A toy (15cm high, 10cm wide) was always used in the hiding game, to be hidden by the children. 12 boxes in which children could hide this toy were placed on one side of the one-way mirror, and a stool was located on the other side. A shade with the same size as the one-way mirror was hanging during the experiment so that the 12 boxes were divided into two parts: "before" part where contained 9 boxes, and "behind" part where contained 3 boxes (Figure 4, both "before" and "behind" were referred to their locations to the shade). Children were tested in one session of about 40 minutes. The balanced procedure was the same as what we used in Experiment 1.

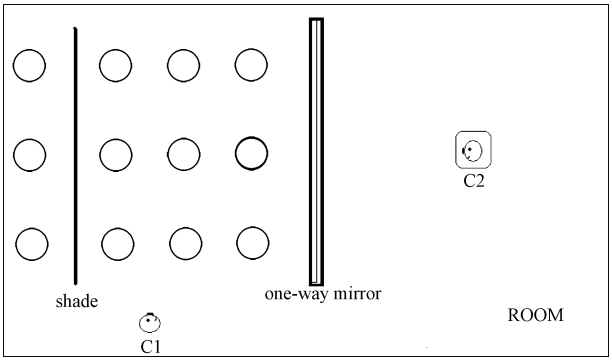

Figure 4. Aerial view of the experimental layout

Note. C1, C2 represented the two children taking part in a session. There was a one-way mirror in the middle of the testing room. The 12 round boxes on the left were obscured, and were used for hiding the toy, whilst the square stool on the right was for C2 to sit on. During the trial presented in the figure, C1 could see anything in the opposite side of the one-way mirror (*transparent condition*); and after both of the children played the role as C1, the same test was done on the other side of the one-way mirror again. And in this new trial, C1's behavior could not be seen from the other side (*obscured condition*).

2.1.3 Procedure

Before the experiment, there was a warm-up procedure, which was identical to that employed in Experiment 1. After that, one of the experimenters showed and taught the children how to hide the toy in a box. Then, while C1 (child 1 in Figure 4) stayed with boxes, C2 (child 2 in Figure 4) sat on the side of the one-way mirror opposite to the boxes, keeping staring forward at the one-way mirror. Then, the experimenters guided C1 to see where C2 was, and asked him to stand at the location showed in Figure 4. Finally, the experimenters asked C1 to choose a box of the 12 to hide the toy, in order not to be found by C2 after his/her hiding. Then, C2 went to find the toy, and C1 was asked, "Where was C2 when you were hiding the toy just now?" (Memory-control Question), followed by the Level 1 Perspective-taking Question, "Could C2 see you when you were hiding the toy? " The children's behaviors and verbal responses were recorded, and the verbal task was always following the behavioral task, when C1 finished his/her hiding.

There were other two behavioral control trials (control 1 and control 2) similar to the experimental trial described above. The only difference between control 1 and experimental trial was that there was no shade when C1 was hiding. Thus, control 1 was designed to check whether children's behaviors were the outcome of hiding preferences or the of use of a strategy like hiding the toy as far from the one-way mirror as one could. For Control 2, the mere change to experimental trial was that C2 was not on the other side of the one-way mirror when C1 was hiding. Control 2 was also designed to check whether children's behaviors were out of hiding preferences or using the strategy that just hiding the toy behind the shade. The orders of these three trials were balanced within each age group.

After C1 had finished all the three trials, the children changed their roles with each other, and repeated the whole experiment. Then, the same test was done on the other side of the one-way mirror again. The initial hiding place was balanced within each age group. Overall, each child played at hiding the toy three times on each side of the

one-way mirror.

2.1.4 Coding and scoring procedure

The coding method of children's verbal responses score was identical to that used in Experiment 1. Six children (one was 3 years old, three were 4 years old, and two were 5 years old) failed to answer the memory-control question correctly, and were excluded from the analysis in use of the verbal responses score. For the Level-1 Perspective-Taking Question, the coding procedure was: when C2 was at the transparent side, the child who answered "yes" could get 1 mark, otherwise they would get 0. Correspondingly, when C2 was seated at the obscured side, the child who answered "no" would get 1 mark, and other answers scored 0. Hence, children's s verbatim data for level 1 perspective-taking ranged from 0 to 2 marks. In the behavioral tasks, including the behavioral part of the experimental trial and both of the two control trials, coding was done based on a live judgment by the two experimenters. Performances in which the child hide the toy in the boxes behind the shade would get 1 mark, otherwise they would get 0.

Referring to the observation of the children's hiding behaviors during the experimental trial in the *transparent condition*, both of the two experimenters classified children's behaviors that might demonstrate their level 1 perspective-taking into 5 categories: (1) Staying behind a given box, while hiding the toy into the other box next to the specific one. (2) Lowering the body weight when hiding the toy so that the child at the other side of the one-way mirror might be hard to figure out their locations. For example, some children crept to hide the toy. (3) Looking directly through the one-way mirror at the opposite side when they had not decided which box to hide the toy in. (4) Going to the other side of the one-way mirror and looking through it after they finished hiding the toy. (5) Telling themselves something related to their situation, such as "he can see me through the mirror", "from one side one can see the other side, while not vice versa". Then, the two experimenters recorded and encoded children's performances independently in terms of the target behaviors classified above: if one performed a specific kind of behavior of the five, the score of this behavioral category was marked with 1, otherwise, was marked with 0. Then, we summed up their scores to all the five categories (ranged from 0 to 5 marks), Besides, the location children chose to hide the toy in the experimental trial of the *transparent condition* also indicated their perspective-taking, and it was a kind of behavioral performances. Hence, we obtained children's final behavioral scores by adding the scores to the location and scores to the performances together (ranged from 0 to 6 marks). Inter-observer reliability was assessed based on all of the 60 children. The observers' judgment matched in 100% of the trials. Cohen's kappa was thus $\kappa = 1$.

2.2 Results and Discussion

2.2.1 Children's behavioral performances

Children's behaviors (hiding location, behind or before the shade) were compared between experimental trial and control trials, in the *transparent condition*, there were significant differences between control 1 and experimental trials ($z = -2.67$, $p = 0.008$), as well as control 2 and experimental trials ($z = -3.74$, $p < 0.0001$). In the *obscured condition*, the difference between control 1 and experimental trial was not significant ($z = -0.00$, $p = 1.000$), while the difference between control 2 and the experimental trial was significant ($z = -2.89$, $p = 0.004$). Thus, it seemed that children's performances in the *obscured condition* were partly the outcomes of using strategies or personal preferences to hide the toy as far from the one-way mirror as they could.

Comparing children's behaviors (hiding location) between different conditions, there was only a trend of difference between their performances in the *transparent condition* and *obscured condition* ($z = -1.67$, $p = 0.096$) for the 3-year-olds. In particular, the 3-year-olds tended to

hide the toy behind the shade more often in the *transparent condition* than in the *obscured condition*. To the 4- and 5-year-olds, however, the differences were not significant (4-year-olds, $z = -0.30$, $p = 0.76$; 5-year-olds, $z = -0.00$, $p = 1.000$). In order to further examine the relationship between children's performances, we investigated the pattern of children's behaviors and the number of children of each age whose performances fit those patterns. Similarly, the behavioral patterns displayed that the number of children who performed the expected behaviors – hiding the toy behind the shade in *transparent condition* while in front of the shade in the *obscured condition* – in our experiment decreased as the age advanced. The 3-year-olds preferred to hide the toy before the shade in the *obscured condition*, and most of them (14/19) followed this way. However, they did not demonstrate this preference in the *transparent condition*, less than 50% (9/19) children did so. Many children chose to hide the toy behind the shade in both conditions, and older children tended to follow this pattern more frequently (Table 2). Chi-squares test applied to compare children's behaviors with chance level (if a child hid the toy by chance, the probability that he/she hid the toy behind the shade and got 1 mark would be 3/12, that is 25%) also showed that only the 3-year-olds, in the *obscured condition*, hid the toy by chance. Children in all the other conditions across different ages hid the toy behind the shade more often than chance level.

Table 2
Number of children in each age whose performances fit patterns

In transparent condition	*In obscured condition*	3 years old	4 years old	5 years old
Behind the shade	Behind the shade	3	7	12
Before the shade	Behind the shade	2	6	1
Behind the shade	Before the shade	7	5	1
Before the shade	Before the shade	7	6	3

Note. It was obvious that most 3-year-olds tended to hide the toy before the shade in the *obscured condition*, while only half of them did so in the *transparent condition*. To 4-year-olds, however, their performances distributed among the four patterns equally. And 5-year-olds clearly preferred to hide the toy behind the shade in both conditions.

Logistic regression analysis used to investigate the age effect within each condition showed consistent results. In the *transparent condition*, the age effect was not significant ($B = 0.488$, Wald = 1.95, $p = 0.163$), for all the children tended to hide the toy behind the shade. However, children's performances in the *obscured condition* differed significantly across ages ($B = 1.109$, Wald = 8.22, $p = 0.004$). Specifically, in the *obscured condition*, younger children preferred to hide the toy in front of the shade whereas older ones were more likely to hide the toy behind the shade (the difference between 3- and 4-year-olds was significant, $p = 0.013$; the difference between 4- and 5-year-olds was not significant, $p = 0.052$; and the difference between 3- and 5-year-olds was significant, $p < 0.0001$).

Taken together, the results revealed that 3-year-olds had already known others' visual perspectives in the current experiment. They chose to hide the toy behind the shade in the *transparent condition* much more frequently than chance level and that in the *obscured condition*. Older children not only possessed the basic ability of level 1 perspective-taking, but also acted upon the best way: hiding the toy behind the shade in both conditions could be accurate and the safest. These results replicated what we found in Experiment 1, and further warranted that, in use of the nonverbal task, we might find the development of strategy generation and adoption.

2.2.2 Comparison of children's behavioral and verbal performances

Similar to Experiment 1, to compare the behavioral data and verbatim data directly, we transformed them into standardized scores (Table 3).

A 3 (age) × 2 (gender) × 2 (task type) mixed-design ANOVA with task type as a within-subjects factor showed that there was a significant effect of age, F (2, 48) = 9.96, $p < 0.0001$, $\eta^2 = 0.29$. Specifically, the 5-year-olds' overall data (including behavioral and verbatim data) were much higher than both the 3- ($p < 0.0001$) and the 4-year-olds ($p = 0.004$), while the latter two did not differ significantly. A three-way interaction between age, gender and task type was significant, F (2, 48) = 3.55, $p = 0.037$, $\eta^2 = 0.13$. However, neither gender nor task type had any main effect. None of any two-way interactions had significant effect.

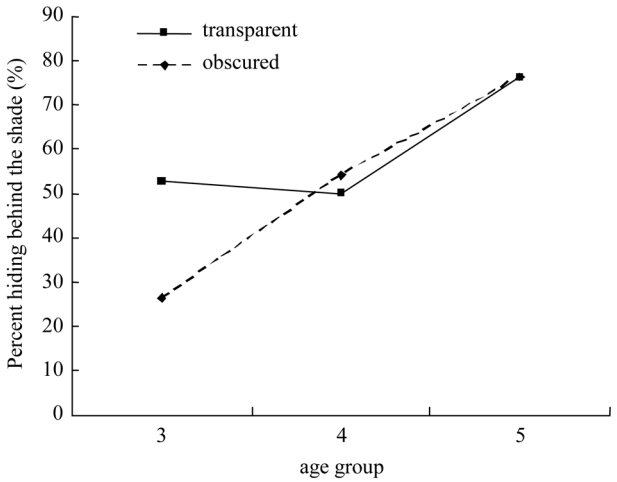

Figure 5. Percents of children by age hiding the toy behind the shade

Table 3
The descriptions of children's behavioral data and verbatim data *M* (*SD*)

Behavioral and verbatim data	3-year-olds		4-year-olds		5-year-olds	
	Girls	Boys	girls	Boys	girls	Boys
Behavioral data (raw: 0-6)	0.60 (0.70)	0.67 (0.71)	1.00 (0.90)	0.85 (1.00)	1.89 (1.36)	2.00 (1.60)
Verbatim data (raw: 0-2)	1.00 (0.67)	1.25 (0.46)	1.11 (0.60)	1.50 (0.52)	2.00 (0.00)	1.33 (0.52)
Behavioral data (standard: z-score)	–0.50 (0.60)	–0.37 (0.61)	–0.06 (0.80)	–0.23 (0.86)	0.61 (1.17)	0.71 (1.38)
Verbatim data (standard: z-score)	–0.63 (1.13)	–0.20 (0.78)	–0.44 (1.01)	0.22 (0.88)	1.06 (0.00)	–0.06 (0.87)

We further analyzed the three-way interaction by dividing it in terms of the task type. Referring to children's behavioral data, a 3 (age) × 2 (gender) ANOVA showed that children's behavioral performances differed significantly across age, F (2, 50) = 6.40, $p = 0.003$, $\eta^2 = 0.20$. Specifically, the 5-year-olds performed much better than both the 3-year-olds ($p = 0.003$) and the 4-year-olds ($p = 0.035$), while the latter two did not differ significantly. This suggests that 5-year-olds, both boys and girls, demonstrate many more behaviors indicating level 1 perspective-taking than the younger participants. None of the remaining effects were significant (Figure 6).

Referring to children's verbatim data, a 3 (age) × 2 (gender) ANOVA revealed that children's verbal performances differed across age, F (2, 48) = 4.49, $p = 0.016$, $\eta^2 = 0.16$ (Figure 6). The correct responses of the 5-year-olds were significantly higher than those of the 3-year-olds ($p = 0.014$). However, there were no significant differences between the 3- and the 4-year-olds, and between the 4- and the 5-year-olds. The two-way interaction of age and gender was significant, F (2, 48) = 4.94, $p = 0.011$, $\eta^2 = 0.17$. Two one-way ANOVA analysis identifying the effect of age within each gender showed that, this significant age effect was only limited to girls, F (2, 25) = 10.05, $p = 0.001$. Concretely, the 5-year old girls were more likely to answer the perspective-taking questions correctly than both the 3- ($p = 0.001$) and the 4-year old girls ($p = 0.004$).

Therefore, based on this behavioral task and the more elaborate encoding of children's behaviors, we were able to detect the deviation between behavioral and verbal performances, which interacted with age and gender. In girls, their behavioral and verbal performances showed similar developmental pattern, 5-year-old girls not

only performed more target behaviors, but also gave more correct answers to the perspective-taking questions than the younger ones. In boys, however, their behavioral performances showed similar developmental pattern to girls, yet this developmental pattern did not apply to their verbal responses, which improved only a little from 3 years old to 5 years old.

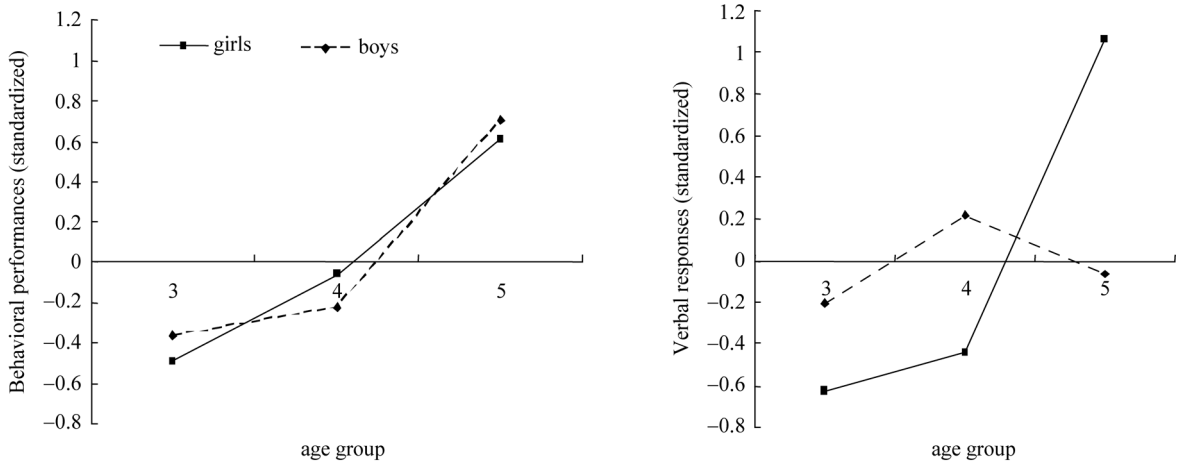

Figure 6. Mean of children's behavioral data (standardized) and verbatim data by age and gender

3 General Discussions

We made use of the one-way mirror and behavioral tasks in two experiments to test children's level 1 perspective-taking. The direct comparison between children's behavioral and verbal performances indicated that there are different development tendency between these two task, which interacted with children's age and gender. The findings also suggested that, 3-year-old children had already scored high in the level 1 perspective-taking test, there was still room for the older children to improve their performances along with the corresponding development of the use of strategies.

The behavioral task we designed in Experiment 2 seems to be an appropriate and effective test to assess children's level 1 perspective-taking. On one hand, the result that 3-year-olds demonstrated the level 1 perspective-taking clearly was consistent to what had been found before (Flavell et al., 1981; Flavell, 1999; Masangkay et al., 1974; Moll & Tomasello, 2006). On the other hand, Povinelli (1996) argued that verbal response was the most reliable approach, for researches in use of nonverbal tasks could be explained by learning-reinforcement or some other lower level abilities. However, to succeed in our task, children had to perform actively, and suppress the inclination of hiding the toy before the shade. Besides, there was only one experimental trial in each condition, which made it impossible to explain the results with learning-reinforcement. Thus, the current study excludes Povinelli's arguments.

However, there was an age discrepancy between our results and previous studies addressing children's level 1 perspective-taking. Firstly, in the classical verbal task, Masangkay et al (1974) found that 3-year-olds' performances were near ceiling – eight of the nine 3-year-olds in their study responded correctly on the verbal tasks. In the current study, however, the percent of 3-year-olds who answered both perspective-taking questions correctly was 22.2%. This discrepancy might be attributed to the different demands of the verbal tasks. In our experiments, children answered two perspective-taking questions, once in one condition, and they were requested to complete the verbal task after the behavioral task which lasted

from 10 (Experiment 1) to 40 (Experiment 2) minutes. Thus, the current verbal task was more demanding on children's memory capacity. Besides, if we considered those who passed one of the two verbal perspective-taking questions as having obtained the level 1 perspective-taking, the proportion of the 3-year-olds who responded correctly on the verbal tasks approached the ceiling effect (about 88.9%). Therefore, although there was a discrepancy between our verbatim data and previous one, the current verbal task was still effective in demonstrating children's level 1 perspective-taking.

Secondly, referring to the behavioral performance, previous non-verbal studies found that 2-year-olds showed explicit understanding of level 1 perspective-taking in these tasks (Flavell et al., 1978; McGuigan & Doherty, 2002; Moll & Tomasello, 2006). Nevertheless, 3-year-olds demonstrated this ability in the current non-verbal tasks. The youngest children tested in our experiments were 3-year-olds. Supporting the notion that children younger than 3, such as 2-year-olds could also demonstrate the level 1 perspective-taking in our nonverbal tasks. On the other hand, as we could not rule out the potential age differences, we speculated that it might be due to the higher requirements of children's executive function in the current study (Hill, 2004; Miyake, Friedman, & Emerson, 2002). In order to perform correctly, children have to plan and monitor their abilities to hide the toy, inhibit the inclination of hiding the toy before the shade, and even apply strategies to perform better. On the contrary, in the previous non-verbal tasks such as the one designed by Moll and Tomasello (2006), children only simply chose one toy out of two and handed it to the experimenter. The non-verbal task used in the current study may appear more difficult to the younger children, and may result the observed age discrepancy.

The three-way interaction found in the current study was consistent with our hypothesis that the verbal performances of girls were superior to boys across the verbal tasks. This difference also alerts us to develop an appropriate nonverbal task to supplement tasks that merely capture verbal responses, in order to better assess the level 1 perspective-taking in children (Moll & Tomasello, 2006; Siegal & Peterson, 1994).

One issue warranted further discussion is the development of strategies generation and adoption associated with the use of the nonverbal tasks in the current study. Previous studies showed that children could use a variety of strategies in tasks which involved problem solving, motor activity, memory or reasoning (Coyle & Bjorklund, 1995; Geary, Fan, & Bow-Thomas, 1992; Schauble, 1996). In the current Experiment 1, we speculated that older children's obvious refusal to follow E2 might reflect the development of strategy use: although they were not sure which experimenter gave the correct information, they might be certain that the safest way was to exclude the most impossible choice. The results in Experiment 2 showed that older children not only possessed the basic ability of level 1 perspective-taking but also acted upon the best way, i.e., hiding the toy behind the shade in both conditions could be accurate and the safest. These results support the statement that nonverbal task could provide us more information of level 1 perspective-taking development.

Moreover, some studies and theories have demonstrated that, as children grow older, their level 1 perspective-taking would develop to some higher level, such as level 2 perspective-taking, theory of mind and so on (Barnes-Holmes, McHugh, & Barnes-Holmes, 2004). Our findings showed that, when the children grew older, they could also use some strategies more effectively to help them make use of level 1 perspective-taking better. Taken together, the results of previous studies and our research might point out another direction of level 1 perspective-taking development, and the combination of both directions may provide us more information about children's cognitive development.

However, one problem might exist in the

procedure of Experiment 2, because we always asked children to answer the verbal questions after they had completed the nonverbal task, it was possible that C2's finding performance may have some influence on C1, leading to the result that C1 got to realize that C2 might have (or have not) seen him during the experimental trial for they did (did not) know where to find the toy. Thus, their verbal responses might not reflect C1's initial thoughts during the experiment, but the updated one after C2's finding performances. However, the results still indicated that children's verbal responses developed little, but their behavioral performances improved a lot and became better than their verbal responses (especially in male children). Therefore, it was reasonable for us to rule out this problem. Nevertheless, future study should balance the order of the nonverbal and the verbal task in order to rule out this potential effect.

The current study reserves a few limitations. Firstly, the classification of the children's behaviors was arbitrary and crude in nature. It was possible that there might be more (or less) categories of behaviors which could indicate their level 1 perspective-taking in our experiments. However, the high kappa agreements obtained between the experimenters might suggest that the current classification was at least reliable between raters. Although we found significant results in the current study, these results might be more convincing if we could recruit more children. Moreover, we found that there might be practice or learning effects of the use of strategies when children had mastered the basic level 1 perspective-taking. Therefore, we should be cautious in interpreting these results and should be alert to other contexts in which children's other skills of higher level, such as the level 2 perspective-taking, might be assessed.

In conclusions, the current study found that there was a significant difference between behavioral data and verbatim data in children aged 3- to-5-year-old. There was also an interaction found between task type, age and gender. We speculated that the older children's performances kept on improving as there was a parallel improvement in the use of strategies in the current sample. These findings suggest that the use of behavioral tasks may provide additional information to tasks designed merely to capture verbal responses when assessing level 1 perspective-taking in children.

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行为表现与言语报告：3~5 岁儿童的一级观点采择

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摘 要 为考察 3~5 岁儿童一级观点采择的行为表现与言语报告之间的潜在差异, 本研究采用"单面镜"范式设计了两个实验。实验 1 中, 54 名儿童成对与实验者一起完成观点采择游戏, 逻辑回归分析结果表明 3-5 岁儿童的行为表现不存在显著差异(B = –0.225, Wald = 0.38, p = 0.541)。方差分析也没有发现儿童的行为表现和言语报告存在差异。由于实验 1 中的编码系统存在一些局限, 并且缺少对儿童偏好的控制, 因此在实验 2 中进行了改进。实验 2 选择了另外 60 名 3~5 岁儿童完成藏玩具游戏。方差分析发现了实验范式类型(行为表现或言语报告)、年龄和性别的三因素交互作用(F (2, 48) = 3.55, p = 0.037, η^2 = 0.13)。结果表明随着年龄增加, 男孩与女孩一级观点采择的行为表现都显著提高, 而男孩言语报告的提高程度显著低于女孩。总体而言, 考察儿童一级观点采择时, 行为表现可能比言语报告提供更多信息。

关键词 观点采择; 策略使用; 行为表现; 言语报告

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